AIR-SHOWERS IN SPACE AND Z-SHOWERS IN UNIVERSE FOR NEUTRINO ASTRONOMY AND SPECTROSCOPY

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Abstract

Amplified Tau-airshower at horizons may well open a novel powerful windows, at PeV-EeV energy, to Neutrino Astronomy. Neutrino induced air-showering astronomy rise because of neutrino masses, their mixing and the consequent replenishment of tau flavor during neutrino flight into spaces; Tau-Air-Showers escaping the Earth are the main traces amplified by its millions muon, billions gamma and thousand billions photon secondaries. Earth edges and its sharp shadows is the huge beam-dump detector for UHE neutrino and the almost noise-free screen for tau air-showers (as well as for PeVs anti-neutrino electron scattering on air electrons by resonant interactions). Crown array detectors for horizontal Cherenkov signals on mountains, on balloons and satellites widening the solid angle view are being elaborated; deep and wide valleys are considered. Tau Air-Showers neutrinos at EeV energies might rise in AUGER, facing the Ande shadows and eventually linking twin fluorescence telescopes to better test horizontal-inclined Cerenkov blazing photons. Tau air-showers may be revealed in ARGO being located within a deep valley testing inclined showers from the mountain sides; MILAGRO (and MILAGRITO) on a mountain top might already hide records of horizontal up-going muon bundles due to far UHECR and less far (but rarer) tau air-showers at EeV. MAGIC (or Veritas and Shalon) Telescopes pointing downward to terrestrial grounds acts, for EeV Tau neutrino air-showers astronomy, as a massive tens of km^3 water equivalent detector, making (in a given direction) it at present the most powerful dedicated neutrino telescope. MAGIC facing the sea edges must also reveal mirrored downward UHECR Air-showers (Cherenkov) flashes. Magic-crown systems may lead to largest neutrino detectors in near future. They maybe located on top mountains, on planes or balloons or in satellite arrays. They may be screened in deep valleys. Finally within cosmological relic light neutrino mass bounds (suggesting $\Sigma m_i \simeq 0.18eV$) a nearly degenerated neutrino mass $m_i \simeq 0.06eV$ rises offering future possible Z-Showering signals originated by $E_\nu \simeq 60ZeV$ and UHECR secondaries above GZK cut-off, up to $E_p \simeq ZeV$.

1 Introduction: UHE ν astronomy at sight

Since Galileo we enjoyed of an optical view first of the planets, stars, and later galaxy maps while, since last century we enlarged the astronomical electromagnetic windows in radio, infrared, UV, X, γ with great success. Now a more compelling UHE ν astronomy at EeVs energy is waiting at the corner. It is somehow linked to a very expected new particle astronomy: the UHECR at GZK energy $\geq 4 \cdot 10^{19}$eV: it must be a limited and nearby one (tens Mpc) because of cosmic BBR opacity. There have been since now two successfully neutrino astronomy at opposite low energy windows: the solar and the supernova ones. The solar ones has been explained by Davis,Gallex, SK, SNO experiment in last four decades opening the ν physics to a solar neutrino mass splitting and a clear probe to its mixing behavior. The supernova SN 1987A was an unique event that anyway had a particular expected signatures at tens MeV. On going experiment on cosmic supernova background in S.K. are at the threshold edges, possibly ready to a discover of this cosmic background. However there is a more exciting and energetic ν astronomy at PeV and EeV energy associate to the evidence of charged UHECR spectra at EeV and tens hundred of EeV band. Indeed any EeV CR originated nearby an AGN or GRB or BL Lac jet will be partially screened by the same source lights leading to a consequent photopion production, associated with PeV secondary neutrinos. In a much simpler and guaranteed way, at energy about $4 \cdot 10^{19}$eV, UHECR should propagate in cosmic photon black body, being partially arrested by photopion productions, (GZK cut-off), leading to EeV neutrinos all along the Universe confines. These UHE ν components, consequence of the GZK cut-off, are called cosmogenic or GZK neutrinos. Their flux may be estimated by general arguments and there is quite a wide consensus on such neutrino GZK flux at EeV energies. These *guaranteed* neutrinos may be complementary to possible *expected* higher energy neutrinos (at ZeV energies) whose role might explain UHECR isotropy and homogeneity being originated at cosmic distances. In this model UHECR born as nucleons via $\nu + \bar{\nu_R} \rightarrow Z \rightarrow X + N$ (Z-burst or Z-shower model) [9], [32], [31] are overcoming present (AGASA,HIRES,AUGER) un-observed local (VIRGO,PERSEUS) source distribution, as would be prescribed by naive GZK cut-off. However GZK neutrinos and Z-Burst neutrinos at EeV are making comparable flux predictions and we shall restrict to the simplest GZK flux assumption. In conclusion we remind the role of neutrino masses in calibrating the Z-Burst showering and the influence in UHECR spectra.

2 Tau air showers connection to neutrino mass and mixing

The tau production is limited,in general,to high energy charmed mesons,whose productions are rare and severely suppressed respect to lower energy pions ones.

For this reason ν_μ,$\bar{\nu_\mu}$ astronomy had a major attention in last century, also for the deeper μ^+,μ^- penetration with respect e^+,e^- and unstable tau. However the definite $\nu_\mu \leftrightarrow \nu_\tau$ (SK data) disappearance and the flavour neutrino mixing has given to ν_τ,$\bar{\nu_\tau}$ a new life and attention. Indeed the additional possibility to oscillate, even at highest energy (10^{19}eV) energy and lowest mass splitting ($\Delta m \simeq 10^{-2}$eV), is guaranteed by the huge stellar galactic and cosmic distance ($\gg$hundred pc).

$$L_{\nu_\mu \to \nu_\tau} = 8.3pc\left(\frac{E_\nu}{10^{19}eV}\right)\left(\frac{\Delta m_{ij}^2}{10^{-2}eV^2}\right)^{-1} \tag{1}$$

respect to the above oscillatory one. In some sense this τ neutrino astronomy offers additional proof of ν mixing.It should be noticed that on principle $\nu_\mu \to \nu_\tau$ appearance may (or is going to) be revealed in SK events.However the conjure of τ large threshold energy (4GeV) and the small Earth radius size make this possibility a different or marginal one.On the contrary a solar flare neutrino ν_μ may travel and reach the Earth at threshold tens GeV energy and convert itself successfully into τ leading to a possible ν_τ neutrino astronomy from solar flare [15].

3 *UHE* $\bar{\nu}_e + e \longrightarrow W^-$, $\nu_\tau \to \tau$, $\bar{\nu_\tau} \to \bar{\tau}$, in air?

As the Z boson peak favors UHE neutrinos in Z-shower model for light neutrino masses ($E_{\bar{\nu}_e} \simeq m_Z^2/2m_\nu \simeq 10$ ZeV $\frac{0.4eV}{m_\nu}$), in the same way $\bar{\nu}_e e \to W^-$ resonance ($E_{\bar{\nu}_e} \simeq m_W^2/2m_e \simeq 6.3PeV$) favors energetic $E_{\bar{\nu}_e}$ hitting and showering beyond mountain barrier (as well as within air horizontal edges). The advantage of a mountain lay is double:a sharp filter for all the horizontal hadronic air shower (and even muon tails) and a dense beam dump where $\bar{\nu}_e e \to W^-$ or $\nu_\tau, (\bar{\nu_\tau}) + N \to \tau(\bar{\tau}) + X$ may take place.These events are double (first νN or $\bar{\nu}_e e$ event and later a τ decay);in water the phenomenon has been noticed nearly ten years ago , see [25]. The idea of this τ showering in water was been considered as the double bang signatures, rarely observable in km^3 detector. The some double bang reformulated *in* and *out*, *in* rock mountains (or Earth) first and *out* within air,later, was the main proposal discussed first at the end of the previous century [10]. In particulary since six years ago , see [13], the upgoing and horizontal air showers has been widely formulated for detention beyond mountain chain, as the Alps and Ande ones. These ideas had been promptly considered for on going AUGER experiment, just nearby Ande mountain chain, see [13] [17], [26]. Later on the same idea of *old* and *regenerated* horizontal air shower have been considered by other authors [2] as well as by a wide list of additional authors [20], [29], [24], [30]. The difference of the τ role in its crossing the Earth lay is in its complex energy loss processes. Ionization, bremsstralhung, pair production and photo-nuclear losses are suppressing the τ primary energy in such way its own lifetime may be shortened suppressing its propagation length. The understanding of the correct interaction length has been noticed by [10] and it has been incorporated on 2000 by [13], and in the complete final τ radiation length [13], [17]. While first and late attempts assumed a fixed β parameter or a linear ones, the β dependence with its logarithmic growth with energy has been considered correctly by [13] (and not other authors) as it has been probed in detail only recently [8].

4 UHE τ versus muon lengths

One of the most common place in ν telescope astronomy is to consider μ because more penetrating than e and τ [13]. This is true in the TeV-PeV energy. However the PeV τ is already to escape a mountain, decay in flight and amplify its shower loudly, respect to a single μ escaping at some energy from a mountain. Moreover the muon logarithmic growth is reached at EeVs by a linear growth of an UHE τ , mostly because if the lepton is heavier, its electromagnetic loss is smaller. Un-fortunately hadronic losses do not allow the τ to increase its penetration but τ is more penetrating a those UHE regime where ν astronomy overcome the atmosphere ν noise, see [13]. In more sophisticated approach, not shown here for sake of simplicity, one may estimate the Earth skin to Tau Air-shower for *shorter* maximal lengths that guarantee a unsuppressed *highest* Tau escape energy; this minimal Earth skin define a smaller volume and lower tau air-showering rate, but at highest $EeVs$ energy [17].

The behavior of τ lengths for most adopted energy losses,the possible definition of a shorter length that guarantee a higher outgoing τ energy,all the detailed Earth profile density for escaping τ and the consideration of the finite atmosphere size for escaping τ air shower, all these details have been analyzed in a tail of recent article [?].Independent attention has grown in studying the upgoing τ flux in km^3 detectors [20], [29], [24], [30]. The general results are not always converging and a summary of the most recently results has been shown (see last fig in ref. [17] for general comparision). comparision). While we have not yet experienced τ definitive air showers , we may foresee that any neutrino τ astronomy will, soon or later, test the τ decay channels. Indeed the main multiple τ decay channel are leading to weighted channel and showers described in PDG table. It will be possible,in principle,to verify by ratio of $\bar{\nu_e} e \to W \to \tau$ *monocromatic* channel versus $\nu_\tau + N \to \tau$ channel, the ν_τ/ν_e abundance and the primary flavour mixing. In a few words τ air shower must be consistent and correlated, in its decay mode by electromagnetic, hadronic and hybrid channel, with well known elementary particle result.

5 Many Roads to Tau Air-showers

There are very advanced experiment that (wherever they are aware or not) might point for Tau Air-Showers, even they were originally thought for other scientific targets. The list of these High energy Showering experiment adaptable to tau Neutrino and Horizontal Showering is here briefly reviewed: 1)Argo, in Tibet; 2) Milagro (and Milagrito) in USA mountains,3) AUGER experiment in Argentina, 4) Space Station Crown Arrays (to be effectively proposed [16]), 5) EUSO telescope, 6) BATSE satellite in CGRO (1991 – 2000 past), 7) ASHRA experiment in Hawaii (now continued by NuTel collaboration), 8) CRTNT Fluorescence array in Utah or China, [3] 9) Muon Array Telescope in Jungfraujoch, [23] 10) Cherenkov Telescopes on High Mountains facing the mountains, like Shalon in Kazakistan. In this view the Magic Stereo Telescopes facing the Earth edges are somehow ideal [19]. The first *Horizons* tests maybe

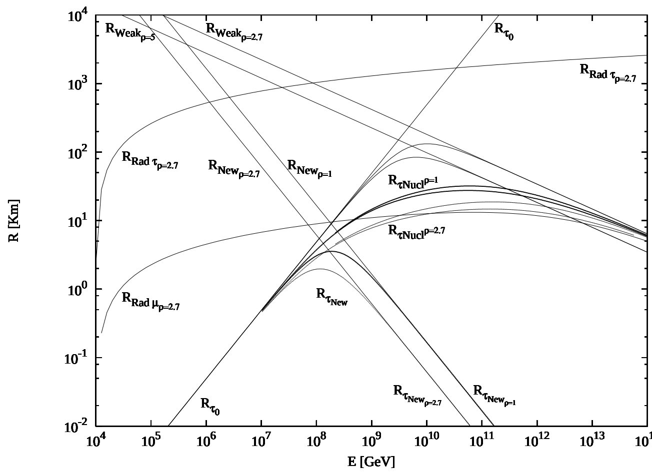

Figure 1: *While tau are extremely unstable and electron are leading to short radiation length, muons are usually the most penetrating lepton; this usually favor underground muon neutrino telescope. However at ultra-relativistic regime tau reach and overcome the muon tracks, making the heaviest lepton the most penetrating. Because life-time linkage to tau energy and to its energy losses,dominated by hadron and pair production, the tau interaction length is derived by an hybrid transcendent equation comparing energy losses and life-time length.*

done possibly in cloudy and otherwise astronomical useless nights. Here below the images and the captions explaining how those experiments may find Tau Air-Showering by a minimal optimized trigger set up.

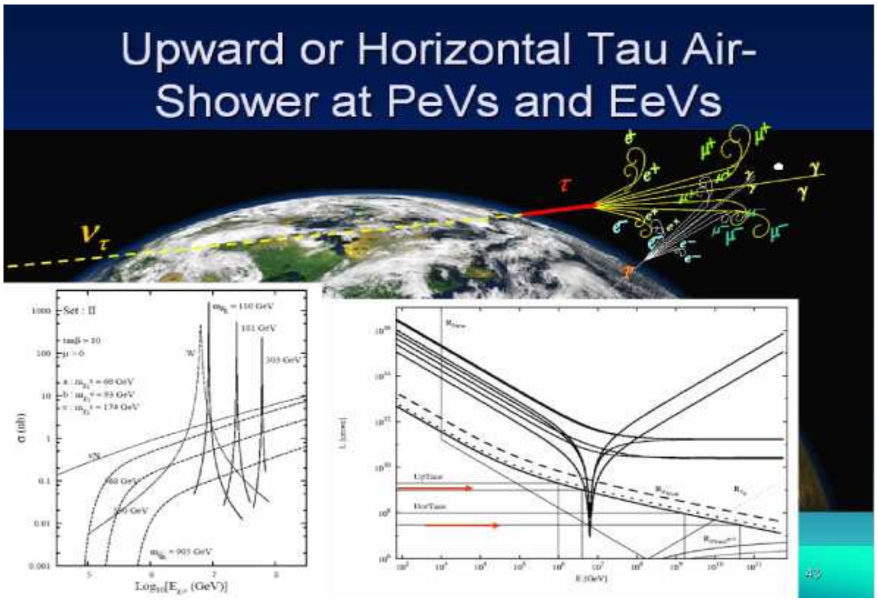

Figure 2: *A schematic view of the possible Horizontal Tau Air-showers at EeVs energy versus a lower PeV vertical up-going Tau Air-Shower. In the left side insert the cross-sections for UHE anti-neutrino with electrons, mediated by* W^- *and the almost comparable UHE neutralino scattering on electron leading to* $\tilde{e_R}$ *whose decay in flight lead also to UHE electromagnetic jet-shower. The consequent interaction length for both neutrino with nucleons and its peculiar anti-neutrino-electron Glashow resonance is shown in the second insert. The Earth diameter in nearly* 10^{10} *cm. water equivalent; therefore the terrestrial neutrino opacity arises above tens PeV energy or inside the narrow resonant Glashow's neutrino peak. To overcome this neutrino opacity one may consider mountain chains or small (PeV) Uptaus or shorter terrestrial cord, for higher energy Hortaus,that are just at the horizons as shown by the red arrows* see [7].

5.1 ARGO

This large area array inside a deep valley in Tibet may record PeVs Tau air-showers emerging from the mountains around. The nearby Chines-Japanese twin experiment may enlarge the area. The presence of more (tens-hundreds) spread (small, few m^2 area) elements at hundred meters one from the other, in vertical structure as well as the covering of the inner wall periphery of the detector house, may greatly increase the ARGO ability to reveal PeVs air-showering below the mountain shapes. The variable opacity to atmospheric GeVs-TeVs muons within the mountain shadows, is a needed test.

5.2 MILAGRO

The existence of huge pools at peak mountains as Milagro and smaller Milagrito, offer an exiting laboratory to verify (besides TeV gamma backgrounds): the muon horizontal fluxes at horizons; the muon bundle density, flux and structures (in comparison with sea-level Nemo-Decor data, see [6], [27]); finally there is the possibility to discover Up-going muon bundles, whose existence maybe indebt only to Earth Skimming (Uptaus) Air-showering.

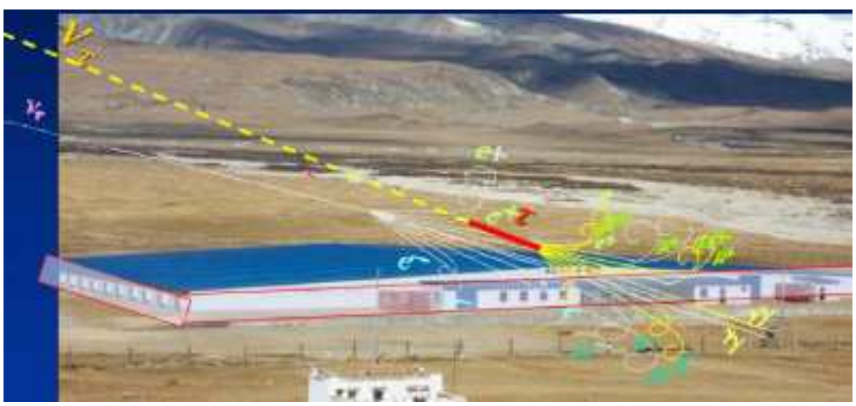

Figure 3: *The possible use of Italian-Chinese ARGO (and its twin nearby Chinese-Japanese array) to monitor, inside a wide deep valley, inclined or horizontal tau air-showers originated by surrounding mountains; the signal may be better revealed by additional array detectors on the walls along the lateral boundaries; these lateral-wall array are in analogy to present Nevod-Decor detector parallelepiped structures, in Russia.*

5.3 AUGER

As in figures and in captions the Auger experiment offer a unique occasion to Horizontal Tau possibly from the West side toward the AUGER detector; to optimize the ability to disentangle these events one should first observe the Ande shadows (at $87-90^o$), zenith angles by a simple asymmetry East-West UHECR showering, see [10], [13] [17], [26]. Within the first year of full operation the shadow *must* be seen. Later on, within the same solid angle of $\simeq 2 \cdot 100 = 6 \cdot 10^{-2} sr$. two event a year by tau Air-showers (via GZK neutrino flux) *might* be very probably observed see [17].

The AUGER Fluorescence detector may enlarge their view also toward the Ande, offering an ideal screen capturing Ande-Tau Showers in horizontal tracks at best. The possibility to use inclined air-shower Cherenkov lights hitting the Fluorescence detector maybe exploited. Multi-telescope coincident Cherenkov detection (while being nearly on axis) of horizontal air-showers maybe applied in all the 12 common directions $(4 \cdot 3)$ in AUGER (and 2 for

Figure 4: *The possible UHECR horizontal or up-going Tau air-showering on Milagro (as well in correlated mode, to nearby Milagrito) while being a TeV gamma detectors: GRB or an active BL Lac at horizons, making nearly* $1-3\%$ *of GRB,SGRs,BL Lac events , might play a role in shining and tracing muon bundles in the Milagro pool waters. As a first estimate, assuming an effective area of few* $10^3 \cdot m^2$ *we foresee one or a few events of Upward muon bundles associated to Tau Air-Showers each year, depending on the trigger, the threshold and geometry.*

stereoscopic HIRES).

5.4 CROWN ARRAYS ON SPACE STATION

From the Space there is the most appealing location to search for Horizontal High Altitudes Showers and Horizontal or Vertical Tau-Air-showers (Hortau-Uptau). This project is still preliminary. The crown-array maybe *both* detecting (tens, hundred keV) gamma secondaries (as well as rarer hundred GeV lepton pairs) as well as Cherenkov lights due to far Hadron and Gamma primary High Energy Cosmic Rays showering from Earth. The array maybe at PeVs-EeVs energy equivalent to few-hundred km. mass neutrino detectors, depending on the telescope sizes and gamma array area.See [12], [16].

5.5 EUSO

The project of a telescope facing down-ward the Earth and catching the UHECR has been delayed to the end of the century. However the idea may offer a way to discover beamed horizontal HorTaus at tens EeV energy showering at high altitudes. Few events , $4-6$, might be observed each year. The EUSO mass equivalent due to Earth-Skimming [20], or HorTaus [13] neutrinos is nearly $100 sr km^3$ [17] water equivalent, even taking into account the 10% duty cycle

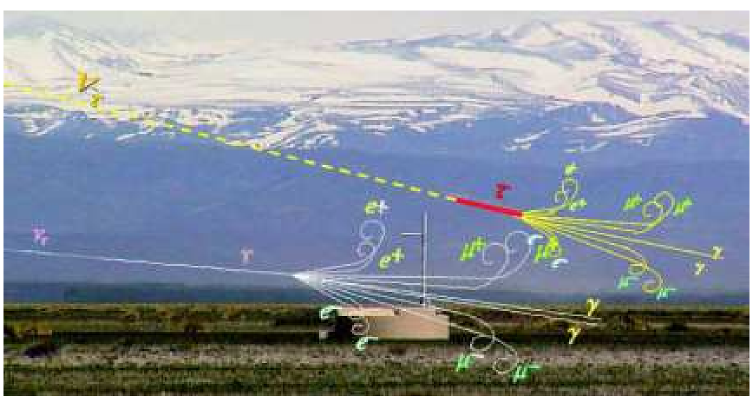

Figure 5: *The long Ande chain mountain is offering a unique wide screening shadows (for UHECR) (opening angle $2-3^o$) and an ideal beam dump (for PeVs-EeVs tau neutrinos) to AUGER array detector. Inside this shadows, that may be soon manifest, rare (a few a year), but quite guaranteed horizontal tau (by GZK neutrino fluxes) air-shower that might be open Neutrino Astronomy windows.*

of the EUSO activity.See [17].

5.6 EOLIC ARRAY

On the top of the mountains small crown arrays of detectors may be mounted on the eolian energy stands. The usual sites (mountain) the power supply, the two different hight on the same element may offer a useful place to build an horizontal Air-shower detector, in wild areas and spread surfaces [16].

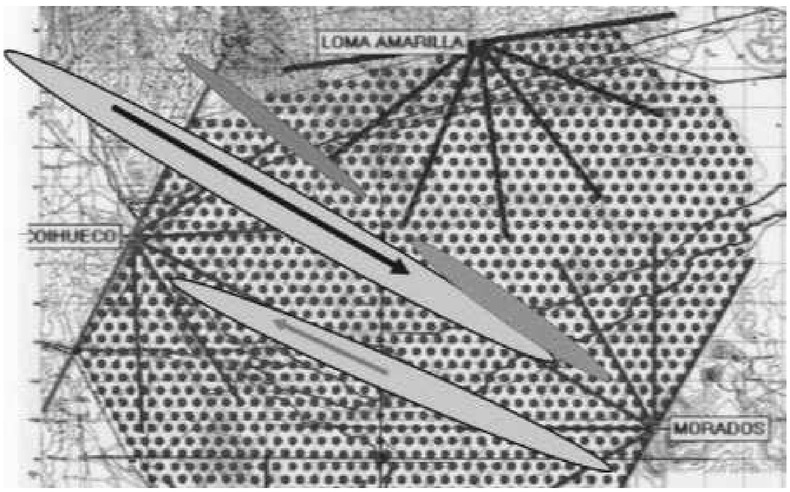

Figure 6: *Inclined Horizontal Air-Showers able to trigger both Auger tanks and Fluorescence telescopes , while being in the same axis. This tecnique, as long the author knows, has never been used to better disentangle horizontal Air-Showers. It may be an ideal detector to observe Tau Air-Showers from the Ande. Their events will populate the forbidden area of large zenith angle at horizons. For this reason it will be useful to: a) enlarge the angle of view of Coiuheco (as well as Loma Amarilla and Leones station) toward the Ande; b) to eliminate any optical filter for Cherenkov lights in those directions ; c) to open a trigger between the Array-Telescope, or Telescope-Telescope in Cherenkov blazing mode; d) to try all* 4 *telescope Fluorescence connection in Cherenkov common trigger-mode along all the* $6 \cdot 2 = 12$ *common arrival directions. Similar connection along the* 360^o *view of stereoscopic HIRES telescopes, might be already done testing along their common horizontal* 2 *axis air-showers (from PeVs up to EeV energy) with high rate (tens-hundreds events a night) and great angular accuracy. In the picture some possible inclined UHECR events shining both array detectors and (by Cherenkov lights) Fluorescence Station; possible twin separated ovals arise by geomagnetic bending.*

5.7 BATSE

Old generation of Gamma satellite in orbit last decade made (with deep discovers by Beppo Sax) most of our view in gamma astronomy. Present and next generation (Swift,Glast) will enlarge the EGRET astronomy by deeper views. The same skimming C.R. or Albedo and Air-Shower tracing by UHECR (PeVs-EeVs) will naturally arise [12].

5.8 ASHRA

Three Fluorescence detectors, in a similar way as AUGER telescopes, are monitoring from the top mountains of the Hawaii island the inner area; their detection maybe greatly enhanced by tracing and calibrating higher altitude HIAS and facing the Earth edges, searching the HorTaus at ocean Horizons.

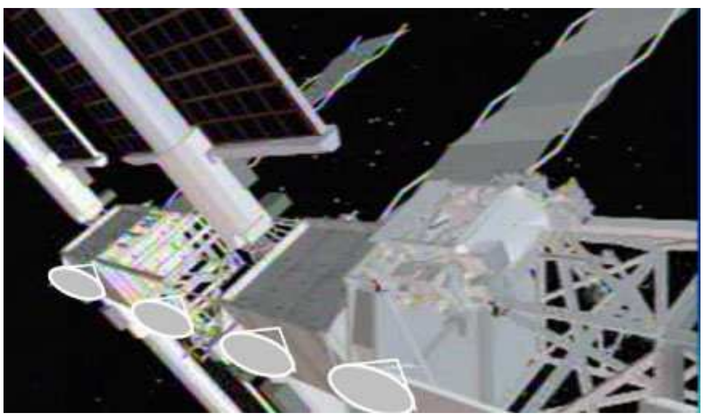

Figure 7: *Space Station constructed and armed with a Telescope Cherenkov Array and a Gamma Array spread array able to disentangle gamma flashes and arrival lights, from the Earth edges. The possible Tau neutrino nature is imprinted by the arrival direction below the Earth horizons, while the UHECR showers arise at the high Atmosphere (Albedo) edges above. The duration of the signal (micro-second to millisecond), as for Terrestrial Gamma Flashes, is the signature of these Up-going Air-Showers, steady ones are the signature of Gamma TeVs-PeVs air-showering sources. The threshold depends on the Telescope and Gamma detector areas; even the distances from Space Station are nearly* $100-200$ *larger than vertical TeV-PeV air-showers on Earth, the beaming is* $14-20$ *smaller, with negligible absorption, making a* 2 *meter square Cherenkov telescope able in principle to observe TeVs gamma sources.)* See 16)

5.9 JUNGFRAUJOCH

The existence in the top Europe turistic station of scientific facilities and fast transport made possible a first test of Muon Telescope Array prototype at horizons site. The proposal of a larger area and more numerous detector is in progress and it may compete with Cherenkov telescope also because of light noise independence of the scintillator array.

5.10 CRNT

The proposal of a Fluorescence array within the cliff shadows is going to be considered in Utah and-or in China. The PeV detection will be possible by low noise light location and Cherenkov aided discovering techniques.

5.11 SHALON

A Russian proposal leaded by Cherenkov TeV-Telescope is already looking from the mountains terrestrial targets in search of eventual Tau air-showers, finding

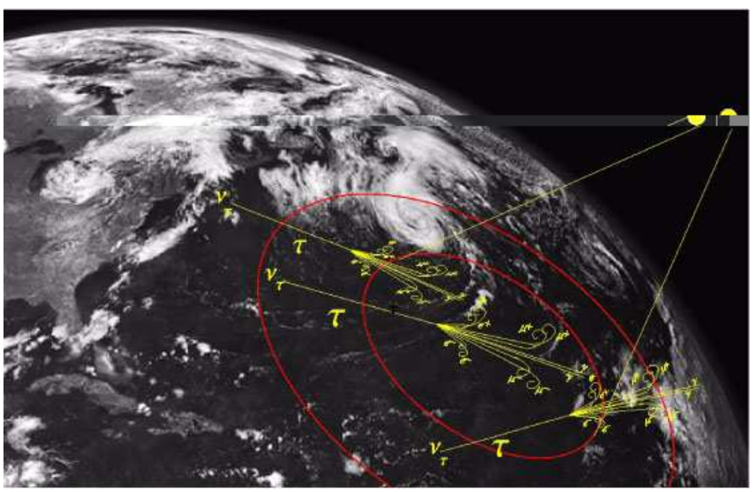

Figure 8: *The up-going horizontal air-showers whose longest (hundreds of km.) air-showers might be detectable by future Euso project; the project would reveal thousands oh UHECR mostly downward events, as well as hundred of horizontal C.R. airs-showers, whose beam angle is extremely small, because low air density. Within these down-going UHECR air-showers there are 4-6 event a year originated within a wider field of view. One of his greatest proponent and great scientist,that with Prof. Linsley discovered UHECR at GZK edges, Prof. Livio Scarsi, sadly has very recently missed.* See [17]

already a statistics on Albedo air-Showers and relevant first calibrations.

6 The Veritas and Magic views of Tau Air-Showers at horizons

Cherenkov gamma Telescopes as last Veritas and MAGIC ones at the top of a mountains are searching for tens GeV γ astronomy. The same telescope at zero cost in cloudy nights, may turn (for an bending angle $\simeq 10°$) toward terrestrial horizontal edges, testing both common PeVs cosmic ray air showers, muon secondary noises and bundles as well as upgoing tau air-showers. Indeed the possible detection of a far air shower is enriched by:

1. early Cerenkov flash even dimmed by atmosphere screen
2. single and multiple muon bundle shining Cerenkov rings or arcs inside the disk in time correlation

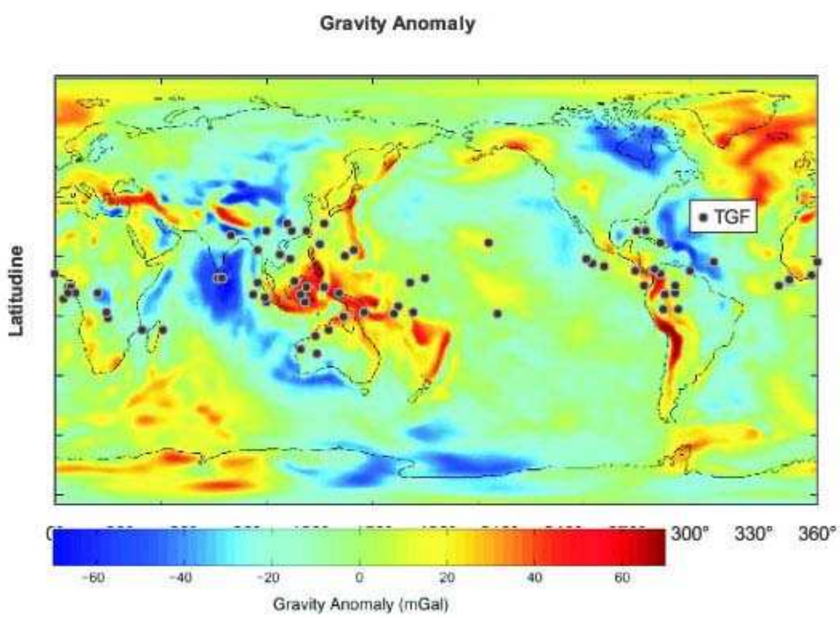

Figure 9: *The apparent correlations between Earth crust contrast, gravity anomaly and the observed location of Terrestrial Gamma Flashes observed by BATSE in last decade (and by RHESSI last two years). The overlap of the TGF events with maximal terrestrial mass density contrast (Mountain chains, sea-islands) (in the equatorial belt where BATSE-Compton trajectory laid), favors a common origin of TGF and tau-airshowers.* See [13], [14]

3. muon decaying into electromagnetic in flight making mini shower mostly outside the disk leading, to lateral correlated gamma tails.

We estimated the rate for such PeVs-EeV events each night, finding hundreds event of noises muons and tens of bundle correlated signals each night [19]. Among them up-going Tau Air-Showers may occur very rarely, but their discover is at hand for dedicated 360^o crown Arrays [16](and arrays of these crowns) in correlation among themselves and scintillator detectors.

The timing of these signals,their expected event rate at PeVs in a night time of Magic at horizon (87^o zenith angle) and their easy signature has been reported recently by Fargion [19].More over the very simple exercise of the estimate of the air cone volume observed at the horizons by MAGIC shows a value larger than $10^3 Km^3$ corresponding to a mass volume larger than $1km^3$ water equivalent.This volume at Glashow resonance energies make MAGIC the must wide ν detector.The some estimate even at smaller solid angle,below the horizon leads a large mass for EeV neutrinos,encompassing volumes and masses as large as $10^2 km^3$.These detectors are active only within a narrow view,but during peculiar rise and down of BL Lac,AGN or Crab like sources, or in coincidence with GRBs along the horizon,the masses enlisted are huge and relevant.To make the detection permanent and in wider angle view the ideal crown array of MAGIC-like telescope on circle and their twin or multiple array structure at few km distance,will guarantee a huge capability to observe an event or few event of τ upgoing shower during a month,within a few tens of UHECR above the edges.

Figure 10: *Ideal arrays of crown scintillators on wind eolic stations.*

7 Conclusions : Neutrino Astronomy and Spectroscopy

Because muon tracks are mostly of downward atmospheric nature the underground neutrino telescope are tracing rarer upward ones mostly of atmospheric origin; higher energy up-going astrophysical neutrino signals are partially suppressed by Earth opacity, and are unique tracks. On the contrary τ air shower at horizons is spreading its signal in a wider area leading to populated (millions-billions) muon and gamma (as well as electron pairs) bundles in their showering secondary mode. This amplified signal may be observed and disentangled from farer and air filtered UHECR, in different ways and places: mountains, balloons, satellites with different detector array area and thresholds. The ad-

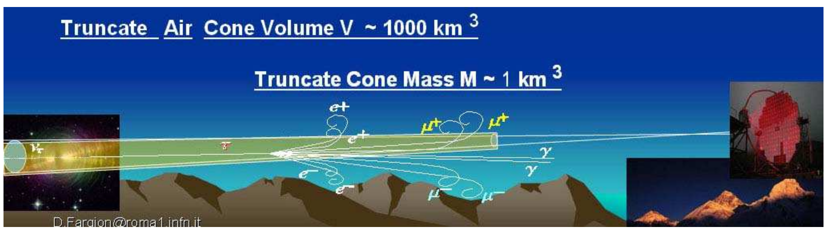

Figure 11: *The possible horizontal air-showering by a GRB or an active BL Lac , whose UHE anti-electron neutrino might resonance with air electrons at Glashow PeVs energies (or in Tau air-showers at higher energy), making nearly 3% of these GRB,SGRs,BL Lac sources laying at horizons for Magic Telescopes. The mass observed , as estimated in figure, within the air-cone exceed the km^3 water mass, even if within a narrow solid angle ($\simeq 4 \cdot 10^{-3}$ sr.)* See [19]

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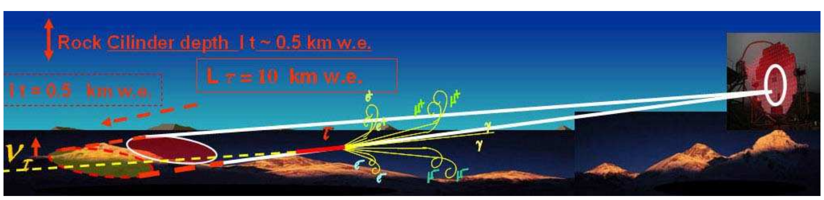

Figure 12: *As above EeVs tau are originated in the Earth crust and while escaping the soil are testing $\sim 70 - 100 km^3$ volumes; later UHE tau may decay in flight and may air-shower loudly toward Magic telescope, within an area of few or tens km^2.* See [19].

vantage to be in high quota is to be extending the visible target terrestrial area and solid angle, as well as to let a longer tau flight distance (and energy), and to enlarge the air shower area; a too high altitude, however , looses solid angle. To make an intuitive estimate the Tau air-shower size area, at tens PeVs-EeVs ,(detectable at horizons within a lateral distance as large as 3 km. from the main shower axis by a telescope like Magic),it is nearly $30km^2$; at EeV energy the equivalent detection depth crossed by the tau lepton before the exit from the Earth reaches $10 - 20km$ distances; the corresponding detection Neutrino volume (inside the narrow, conic $10^{-3}sr.$, shower beam) is within $30 - 60km^3$, in any given direction , see [19]. A few events of GRBs a year may be located within these horizons, as well as AGN and BL Lac in their flare activity. In such occasions Magic, Veritas and Hess array are the most sensitive neutrino telescope at PeVs-EeV energy. Even on average, for a present $2 \cdot 2^o$ view of

Figure 13: *The possible inclined UHECR air-showering on Magic facing the sea side. Their detection rate is large (at zenith angle $80 - 85^o$) (tens or more a night) nearly comparable with those at zenith angle 87^o already estimated; these mirror UHECR shower , widely spread in oval images on the sea (depending on the sea wave surfaces), their presence is an useful test for Magic discovering of point source PeV-EeV UHECR air-showers at horizons. While previous configuration above horizons may correlate direct muon bundle and Cherenkov flashes, these mirror events are polarized lights mostly muon-free, diffused in large areas and dispersed in longer time scales, mostly in twin (real-mirror-tail) spots. On the contrary Up-going Tau air-showers from the sea are very beamed and thin and un-polarized and brief.* See [19].

Magic, at present energy thresholds, such telescopes (for Neutrino at Glashow PeVs energy windows), are testing a total mass-solid angle a comparable or larger than to $10^{-2} km^3 sr$, an order of magnitude comparable with the present AMANDA detector. Moreover the light neutrino mass that seem to converge (by recent cosmic constrains) toward a light degenerated neutrino mass value

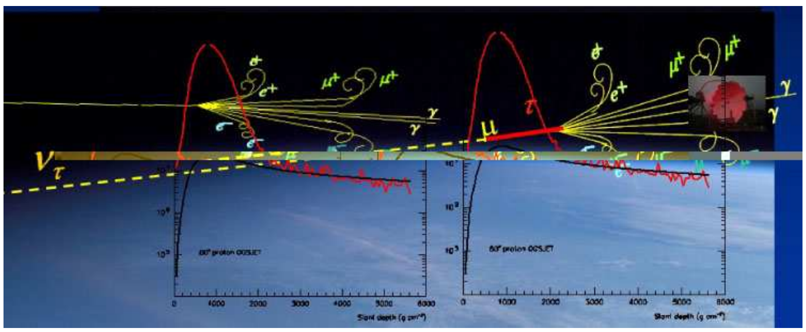

Figure 14: *The horizontal air-showers by far hadron differ to an up-tau air-showers, whose younger electromagnetic and muonic density is greater and much larger ; in the figure the two different signature of the flux densities assuming a Magic telescope observer (not in scale), and an ideal downward far nucleon and a nearby Tau EeV air-showers event.* 4)

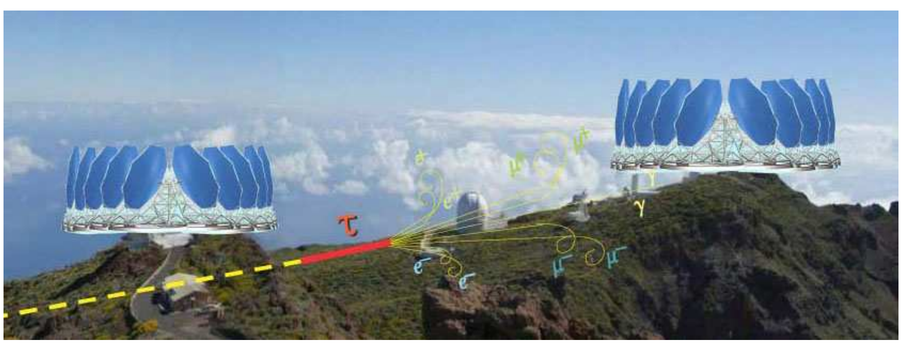

Figure 15: *Ideal arrays of Cherenkov Crowns Telescopes in Canaries and an equivalent twin Crown Array Balloon in flight; similar arrays maybe located in planes or satellites.*

$m_i \simeq 0.6eV$ seem to suggest a UHE primary neutrino at $E_\nu = 60ZeV$ and a UHECR secondary bump at $E = 3.3ZeV$. In this view UHECR modulation at GZK energies may reflect lightest neutrino masses.

In conclusion a maximal alert for the Neutrino air-showering within the Earth shadows is needed: in AUGER, Milagro, Argo, as well as in ASHRA, CRTNT, Shalon Telescopes the signal is beyond the corner. In particular the Magic (and Veritas) arrays telescopes facing from the mountains the Horizons edges may soon test our proposal leading to such crown arrays. In a sentence we believe that the UHE Neutrino Astronomy is beyond the corner, Tau is its courier and its sky lay just beneath our own sky: the Earth.

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